

The *Ministère des Transports, de la Mobilité durable et de l'Électrification des transports du Québec* Develops New Charter to Reduce the Environmental Impact of Road Salt

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Introduction

The Quebec Ministry of Transport, Sustainable Mobility and Transportation Electrification (Ministère des Transports, de la Mobilité durable et de l'Électrification des transports, hereinafter MTMDET) is responsible for the winter maintenance of an extensive road network. In Quebec, local roads (107,000 km) are under municipal jurisdiction, while the MTMDET is responsible for all provincial roads and highways (31,000 km).

The larger part (66%) of the provincial road network is maintained by private sector companies. The rest is maintained by the MTMDET (20%) and municipalities (14%).

Each year, the MTMDET uses over 800,000 tonnes of de-icing agent on its road network in the winter months, which has a considerable negative impact to varying degrees on nearby flora and fauna, water quality, soil quality and infrastructure. Water quality tests conducted in several lakes close to urban areas across the province of Quebec has shown that, in certain locations, chloride concentrations are steadily increasing. And in a few locations, these concentrations have surpassed the chronic toxicity threshold for aquatic life.

Considering that sodium chloride's impact on the environment and on roadway infrastructures is well documented, the responsible use and management of this product is of primordial importance.

The MTMDET Process

For the last 10 years, in keeping with the measures outlined in the Ministry's Environmental Road Salt Management Plan, the MTMDET has worked to improve its environmental record by implementing innovative methods and practices. The MTMDET uses all the tools at its disposal to review and optimize operations and practices on an ongoing basis.

A key component is to ensure that the expertise developed by the Ministry's winter maintenance decision makers is transferred to local operations centres across the province. This expertise integrates the knowledge acquired by local operations teams in response to specific weather conditions in their local environment. The regional diversity reinforces the importance of documenting and assessing winter maintenance practices at the regional level. It is important to collect detailed data on winter maintenance operations.

The Ministry has recognized the importance of compiling detailed data on the use of materials (de-icing salts, brine, abrasives) across the province to ensure healthy economic and environmental management practices. A new software application was therefore developed and distributed to all local operations centres in February 2006. The application is designed to track road salt and abrasives ordered, used and in stock.

This system, known as the Winter Operations Registry (Registre des opérations hivernales – ROH), now contains historical data that can be used to compare the use of these materials across all operations centres and to conduct all analysis work required in support of a process of continuous improvement.

The annual monitoring of orders, deliveries and use of materials has become an invaluable planning and management tool.

In order to optimize the use of road salt across all operation teams, the Ministry conducted an in-depth analysis of its road salt management practices during the 2013-2014 winter season. This included a detailed inventory of product concentrations and proportions in the use of road salt / abrasive mixes. The main objective was to identify best practices on a regional basis.

The main observations included:

- Road salt management practices varied considerably from one operations centre to another, although local weather conditions were in some cases quite similar.
- A broad range of road salt / abrasive mixes was used. Each operations centre had developed a preferred mix for its own operations, which varied considerably from one operations centre to the next.

Certain operations centres mainly use one of two materials (road salt or abrasives) in a pure concentration (100% road salt or 100% abrasive), while others generally use various salt / abrasive mixes. The concentration formula for these mixes is not consistent from one operations centre to the next: some have a higher concentration of road salt, while others have a higher concentration of abrasives.

In light of these observations, the Ministry has undertaken the development of a series of tools to help operations staff make appropriate decisions in the use of road salt and abrasives.

Tools Development

Two key tools were developed:

- Road Salt and Abrasives Application Charts (*Chartes d'épandage*);
- Road Salt and Abrasives Best Practices Guide (*Guide des bonnes pratiques d'épandage*).

The goal of the charts (see Figure 1) was to:

- Develop standardized product application practices (see Figure 2) to ensure continued compliance with the Ministry's prescribed service levels for each road type (expressways, highways, regional roads), and
- Provide a safe and functional network for all road users, while contributing to a healthier environment by reducing the quantity of road salt.

The main purpose of the *Road Salt and Abrasives Best Practices Guide* (see figure 3) is to support the Ministry's operations staff in their day-to-day road salt and abrasives application activities. This reference document describes the meteorological and roadway conditions parameters to take into account the decision-making process and explains how parameters were considered in the development of the Applications Charts.

Developing Charts

The first step in the development of the Application Charts included a review of road salt and abrasives application practices at municipal and national levels. In addition, a survey was conducted with Canadian provinces and territories and major urban centres across Quebec to gather available charts and tools (guides, training programs, etc.) pertaining to road salt and abrasives application practices.

Among the Canadian provinces, Alberta and Manitoba authorities provided their respective material charts. Many Quebec municipalities (Montreal, Sherbrooke and Gatineau) provided charts and tools, although their roadway maintenance practices and activities would differ considerably from the Ministry's own practices. This cross-Canada and provincial review indicated that there are very few charts in use and those that do exist would not be very well suited to the Ministry's requirements and particular nature of the province's road network.

With these charts and other documents obtained, as well as charts previously developed by the Ministry, the MTMDET had the necessary reference materials to develop a new chart encompassing a broad range of road- and weather-based criteria.

Interviews were conducted with private and public sector operations staff to document and develop specific practices in response to specific road environments.

These charts (see Figure 5) incorporate key road and weather factors and notions, resulting from the experience and empirical knowledge of numerous Ministry maintenance personnel. The final product reflects the roadway maintenance results

expected upon completion of the Ministry's standard snow removal and de-icing operations.

In-depth knowledge of meteorological and roadway parameters is essential to make informed decisions on which type of de-icing materials to use and de-icing procedures to undertake.

Parameters include:

- Roadway surface temperature;
- Air temperature;
- Traffic conditions across the road network;
- Dew-point temperature; and
- Wind conditions.

Implementing Application Charts

Any significant organizational change requires time for staff to adapt and adopt new processes. It is important to connect with and mobilize all staff involved in all aspects of winter maintenance operations. At the MTMDET, numerous staff members were involved, which is why the implementation of these new tools was spread out over two winter seasons.

As contractual agreements between the Ministry and private sector contractors could not be amended without consequence, application charts were only implemented in areas maintained by the Ministry's operation teams. At the start of the 2015-2016 winter season, crew leaders were trained on the use of application charts and specific winter maintenance operations to which these charts apply. The quantities of de-icing products used were closely monitored and tabulated throughout the winter. A monthly report on the amount of de-icing materials (road salt, abrasives, mix) consumed was produced and delivered to each operations centre. Operations centres also documented issues encountered in the use of application charts, while specifying application options used in these situations.

In reviewing the comments and suggestions collected from operations personnel during the winter of 2015-2016, project authorities realized that there was no major adjustment needed to application rates indicated in the charts. Charts were however updated and modified to include reminders and footnotes providing additional details on certain parameters and definitions that were not quite understood by several chart users.

Staff members responsible for using the charts were asked to complete a detailed survey at the end of year 1. The majority (74%) of respondents identified the need to offer training sessions to key decision-making personnel (chiefs of operations) and to team leaders, as the latter had not received training during year 1 of the implementation program.

As a result, new training sessions were offered at the beginning of the 2016-2017 winter maintenance season to ensure key personnel received proper training. In total, 345 staff attended the training sessions. Updated versions of the charts and accompanying documents were made available at the beginning of the 2016-2017 winter maintenance season. The new *Road Salt and Abrasives Best Practices Guide* was made available as of February 2017 as an additional tool to support of operations staff.

Organizational and Environmental Gains

The implementation of application charts during the 2015-2016 and 2016-2017 winter seasons has led to significant changes in the Ministry's operational team practices and procedures, by providing a simpler and more defined decision-making process. By clearly establishing the products and mixes to be used with prescribed application rates, the charts have standardized and optimized the use of roadway maintenance products based on road and weather conditions.

Although the implementation of application charts required a great deal of work and effort with the operations teams, it resulted in mobilizing operations staff around a common goal. Operations teams were able to witness first-hand that the use of smaller quantities of road salt and abrasives in day-to-day operations did not diminish the quality of service offered to the public. Road salt and abrasives are now applied more efficiently. The charts have greatly facilitated the decision-making process, as they are user-friendly and consistent with existing operational practices. The application charts and the *Road Salt and Abrasives Best Practices Guide* also provide clear and standardized documentation to assist in the efficient transfer of knowledge and expertise when training new personnel.

According to the data compiled in the *Register of Winter Operations* (Registre des opérations hivernales – ROH), the annual consumption of road salt per kilometre on the roads maintained by the MTMDET has improved significantly in the two winter seasons since the implementation of the application charts.

In its first year of implementation (winter of 2015-2016), the MTMDET reduced its overall use of de-icing agents by 23% compared to the average annual use for the five previous years (see Table 1). In year 2, an additional 9.7% reduction was achieved compared to the five previous years. In total, this represents an approximate decrease of 30,000 tonnes of road salt per winter season for the entire road network maintained by MTMDET. The Ministry will continue compiling detailed road salt use statistics over the next three winters to further validate these findings.

In addition to the cost savings resulting from buying fewer materials, reduced road salt use will have a positive impact on the longevity of roadway infrastructures, which are negatively impacted by road salt (see Figure 4).

The use of road salt is essential and unavoidable during the winter months. However, it is important to avoid overuse and to manage road salt use responsibly. By providing a clear framework, application charts play a key role in reducing the environmental impact of winter maintenance operations.

The expert knowledge developed by the Ministry in the field of winter maintenance serves as a model for municipal authorities, including those who adhere to the *Quebec Road Salt Environmental Management Strategy* (Stratégie québécoise pour une gestion environnementale des sels de voirie). This commitment to environmental stewardship is also beneficial to other road administrations. The *Road Salt and Abrasives Best Practices Guide* and road salt application charts are available on the MTMDET website, by clicking the following link:

https://www.transports.gouv.qc.ca/fr/gestion-environnementale-selsvoirie/Documents/GSV/references-utiles/publications_MTQ/guide-bonnespratiques-epandage.pdf

Conclusion

This major initiative has enabled MTMDET operations teams to optimize their use of road salt and abrasives by achieving:

- A 23% reduction compared to the annual average for the previous five years, during year 1
- An additional 9.7% compared to the annual average for the previous years, in year 2.

The overall environmental footprint of MTMDET de-icing operations has decreased, and the reduction of the quantities of road salt in use has positive effects for the organization.

The MTMDET has undertaken other initiatives in addition to implementing the application charts. Operations centres have experimented with the use of pre-wetted materials for the past several seasons. Preliminary results indicate that this method could result in a 6% decrease of the required quantity of road salt. These positive indications have led the Ministry to develop specific application guidelines for the use pre-wetted road salt (slurry). These guidelines will be added to the existing application charts, which will help optimize application operations when conditions favourable to the use of slurry arise. The MTMDET is currently preparing guidelines to guide the gradual implementation of this new practice in the coming winters.

The MTMDET is very proud of the results achieved in reducing the environmental impacts associated with the use of road salt. The Ministry is continually searching for new ways to improve its environmental bottom line by fine-tuning its tools and by developing new methods and practices in response to evolving needs.

Reducing the environmental impact of road salt New MTMDET road salt application charts

Appendices

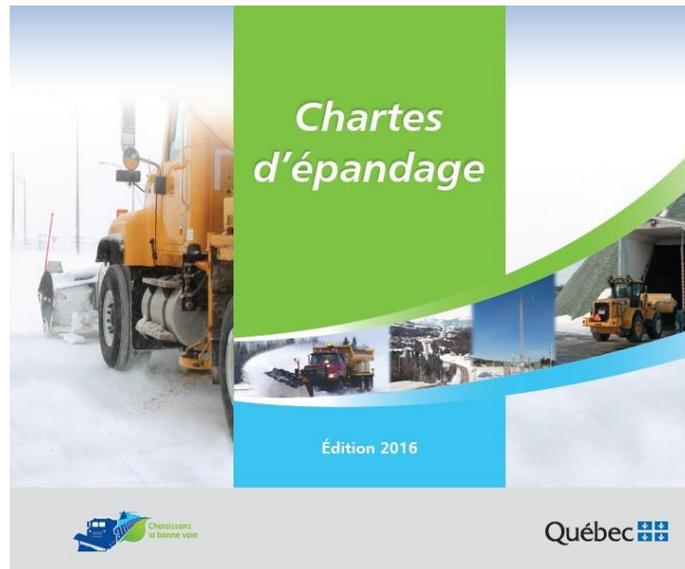


Figure 1 – Application Charts



Figure 2 – Application of de-icing materials



Figure 3 – Road Salt Best Practices Guide



Figure 4 – Impact of de-icing agents on road network infrastructures

Niveau de service – Partiellement dégagée

Cas généraux

T° surface	T° air	Trafic	Sécuriser	État de surface attendu
			Points critiques ⁽¹⁾	Circuit complet ⁽²⁾
0 °C et plus			Au besoin Sel 50 à 80 kg/km	Au besoin Sel 50 à 80 kg/km
0 à -7 °C	↑		Mix A 150 à 200 kg/km	Sel 70 à 100 kg/km
	↓		Mix A 200 à 250 kg/km	Sel 90 à 120 kg/km
-7 à -12 °C	↑	↑	Mix A 200 à 250 kg/km	Sel 100 à 130 kg/km
		↓		
	↓	↑	Mix A 250 à 300 kg/km	Sel 130 à 160 kg/km
		↓		
-12 à -15 °C	↑	↑	Mix A 250 à 300 kg/km	Sel 130 à 160 kg/km
		↓		
	↓	↑	Abrasive 250 à 350 kg/km	Mix A 250 à 300 kg/km
		↓		
-15 à -20 °C	↑	↑	Abrasive 250 à 350 kg/km	Mix A 300 à 350 kg/km
		↓		Abrasive 250 à 350 kg/km
	↓			Abrasive 250 à 350 kg/km
-20 °C et moins			Abrasive 250 à 350 kg/km	Abrasive 250 à 350 kg/km

1. Traitement des points critiques, incluant les surfaces glacées, **au besoin**.

2. Traitement sur tout le circuit à la fin des précipitations (selon les délais) OU traitement sur tout le circuit en cas de perte d'adhérence.

■ SEL de voirie pur ■ ABRASIF de type AB-10 ou AB-5 ■ MIX A : 1 portion de sel (25 %) pour 3 portions d'abrasif (75 %)

Note : les taux d'épandage et les matériaux sont proposés pour une intensité de précipitation, un temps de parcours du circuit et des vents moyens.

Figure 5 – Example: Level of Service Chart – Partially Clear Roadway

English Content for Figure 5

General Cases

Surface Temp Air Temp Traffic Secure Target Surface Condition

Critical Points Complete Circuit

0 degrees and warmer	As needed – Salt: 50 to 80 kg/km	As needed – Salt: 50 to 80 kg/km
0 to -7 degrees	Mix A: 150 to 200 kg/km	Salt: 70 to 100 kg/km
	Mix A: 200 to 250 kg/km	Salt: 90 to 120 kg/km
-7 to -12 degrees	Mix A: 200 to 250 kg/km	Salt: 100 to 130 kg/km
	Mix A: 250 to 300 kg/km	Salt: 130 to 160 kg/km
-12 to -15 degrees	Mix A: 250 to 350 kg/km	Salt: 130 to 160 kg/km
	Abrasive: 250 to 300 kg/km	Mix A: 250 to 300 kg/km
		Abrasive: 250 to 350 kg/km
-15 to -20 degrees	Abrasive: 250 to 300 kg/km	Mix: 300 to 350 kg/km
		Abrasive: 250 to 350 kg/km
-20 degrees and colder	Abrasive: 250 to 350 kg/km	Abrasive: 250 to 350 kg/km

1. Treatment of critical areas, including iced-over locations, as needed.
2. Treatment of the entire circuit when precipitations cease (according to timeline) OR Treatment of the entire circuit when adherence is affected.

100% ROAD SALT ABRASIVE Type AB-10 or AB-5 MIX A: one part Road Salt (25%) for three parts Abrasive (75%)

Note: Suggested application rates and materials are for average precipitation intensity, circuit coverage times and wind conditions.

Table 1 – Materials Usage Rates (tonnes/km) per Administrative Region

Admin. Region	Usage (tonnes/km)		5-year average (tonnes/km)		Variation	
	Season	Season	Season	Season	Season	Season
	2015-2016 Year 1 Chart Implementation	2016-2017 Year 2 Chart Implementation	2015-2016 Year 1 Chart Implementation	2016-2017 Year 2 Chart Implementation	2015-2016 Year 1 Chart Implementation	2016-2017 Year 2 Chart Implementation
Communauté métropolitaine de Montréal	34,4	51,4	57,8	59,1	↓ 40,5 %	↓ 12,9 %
Bas-Saint-Laurent-Gaspésie-Îles-de-la-Madeleine	38,0	40,3	44,9	42,4	↓ 15,4 %	↓ 4,9 %
Mauricie-Centre-du-Québec	28,0	32,8	40,9	37,2	↓ 31,5 %	↓ 11,9 %
Chaudière-Appalaches	34,3	36,8	44,6	41,8	↓ 23,0 %	↓ 12,0 %
Côte-Nord	28,3	22,9	28,0	28,3	↑ 0,9 %	↓ 19,1 %
Saguenay-Lac-Saint-Jean-Chibougamau	32,2	31,2	30,5	30,3	↑ 5,5 %	↑ 3,0 %
Capitale-Nationale	52,5	53,4	57,4	56,4	↓ 8,6 %	↓ 5,3 %
Montréal	22,5	26,0	33,9	31,9	↓ 33,7 %	↓ 18,5 %
Laurentides-Lanaudière	47,0	52,9	56,2	54,1	↓ 16,3 %	↓ 2,2 %
Outaouais	24,7	29,5	32,2	30,9	↓ 23,3 %	↓ 4,6 %
Estrie	22,3	39,4	45,3	39,2	↓ 50,7 %	↑ 0,5 %
Abitibi-Témiscamingue	22,9	20,1	24,0	24,8	↓ 4,7 %	↓ 18,9 %
MTMDET	32,4	36,6	42,2	40,6	↓ 23,2 %	↓ 9,7 %



Figure 6 – Example of a Maintained Roadway